

U.S.S.N. 10,797,945

Claim Amendments

Please amend claims 18, 20, 24, 29, 30, 32, and 38 -44 as follows:

Please cancel claim 37 as follows:

Please add new claims 45-50 as follows:

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Listing of Claims

Claims 1-17 (canceled)

18. (currently amended) A contact interconnect structure comprising:

a semiconductor substrate comprising CMOS devices including active contact regions;

a first contact layer overlying the active contact regions comprising a first plurality of metal filled contact openings extending through the first contact layer thickness to the active contact regions;

a second contact layer overlying the first contact layer comprising a second plurality of metal filled contact openings, each of said second plurality of metal filled contact openings extending through the second contact layer thickness to a respective one or more of the first plurality of metal filled contact openings;

wherein, the first plurality and the second plurality of metal filled contact openings form a physically continuous contact interconnect structure, said first and second metal

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filled contact openings having an aspect ratio of less than about 4.5 with respect to a respective contact layer, said contact interconnect structure connecting said active contact regions to overlying wiring circuitry comprising metallization layers.

19. (previously presented) The contact interconnect structure of claim 18, wherein the bottom portion of said contact interconnect structure has a maximum width of less than about 70 nanometers and an aspect ratio of less than about 4.5.

20. (currently amended) The contact interconnect structure of claim 18, further comprising an overlying metallization layer in electrical communication with the second plurality of metal filled contact openings.

21. (previously presented) The contact interconnect structure of claim 18, wherein the first and second contact layers are selected from the group consisting of PETEOS, BPTEOS, BTEOS, PTEOS, TEOS, PEOX, nitrogen doped silicon oxide, fluorine doped silicon oxide, SiC, silicon nitride, and silicon oxynitride.

22. (previously presented) The contact interconnect structure of claim 18, wherein the first and second contact layers comprise lowermost portions selected from the group consisting of silicon

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carbide, nitrogen doped silicon oxide, silicon nitride, and silicon oxynitride.

23. (canceled)

24. (currently amended) The contact interconnect structure of claim 18, wherein the first plurality and ~~second~~ first and the second plurality of metal filled contact openings comprise conductive materials selected from the group consisting of Cu, W, Al, AlCu, TiN, TiW, Ti, TaN, and Ta.

25. (original) The contact interconnect structure of claim 18, wherein the active contact regions are selected from the group consisting of source and drain regions and gate electrodes.

26. (previously presented) The contact interconnect structure of claim 25, wherein the gate electrode comprises a gate structure having a gate length of less than about 45 nm.

27. (original) The contact interconnect structure of claim 18, wherein the active contact regions comprise a conductive material selected from the group consisting of Ti, Co, Ni, Pt, W, TiSi₂, CoSi₂, NiSi, PtSi, WSi₂, TiN, and TaN.

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28. (previously presented) The contact interconnect structure of claim 18, wherein the first and second contact layers comprises an uppermost portion selected from the group consisting of a hardmask layer and a BARC layer.

29. (currently amended) The contact interconnect structure of claim 18, wherein the first and second plurality of metal filled contact openings comprise a shape selected from the group consisting of circular and rectangular.

30. (currently amended) The contact interconnect structure of claim 18, wherein the first and second plurality of metal filled contact openings are selected from the group consisting of vias, contact holes, butt contact interconnects, and local interconnects, and interconnect lines.

31. (canceled)

32. (currently amended) A contact interconnect structure comprising:

at least first and second stacked contact layers comprising a respective first and second plurality of metal filled contact openings extending through the first and second contact layers to

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a contact region comprising an active transistor region to form a physically connected stacked contact interconnect structure;

wherein, the first plurality and the second plurality of metal filled contact openings comprise a bottom portion having a maximum width of less than about 70 nanometers, said first and second metal filled contact openings and an having an aspect ratio of less than about 3.3 with respect to a respective contact layer, said contact interconnect structure connecting said active contact regions to overlying wiring circuitry comprising metallization layers.

33. (previously presented) The contact interconnect structure of claim 32, wherein the bottom portion has a maximum width of less than about 50 nanometers and an aspect ratio of less than about 4.5.

34. (previously presented) The contact interconnect structure of claim 32, wherein the first and second contact layers comprise an underlying-etch stop layer.

35. (previously presented) The contact interconnect structure of claim 32, wherein the active transistor region is selected from the group consisting of source and drain regions and gate

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electrodes.

36. (original) The contact interconnect structure of claim 35, wherein the gate electrode comprises a gate structure having a gate length of less than about 45 nm.

37. (canceled)

38. (currently amended) A stacked contact interconnect structure for achieving a high aspect ratio comprising:

a semiconductor substrate comprising CMOS devices including active contact regions;

a first contact layer overlying the active contact regions comprising a first metal filled contact opening extending through the first contact layer thickness to the active contact regions;

a second contact layer overlying the first contact layer comprising a second metal filled contact opening extending through the second contact layer thickness to the first metal filled opening;

wherein, each of the first and second metal filled contact

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openings have about the same width to form a physically connected stacked contact interconnect structure, said first and second metal filled contact openings having an aspect ratio of less than about 4.5 with respect to a respective contact layer, said contact interconnect structure connecting said active contact regions to overlying wiring circuitry comprising metallization layers.

39. (currently amended) The contact interconnect structure of claim [[36]] 38, wherein the bottom portion of said contact interconnect structure has a maximum width of less than about 70 nanometers and an aspect ratio of less than about 4.5.

40. (currently amended) The contact interconnect structure of claim [[36]] 38, wherein the first and second contact layers are selected from the group consisting of PETEOS, BPTEOS, BTEOS, PTEOS, TEOS, PEOX, nitrogen doped silicon oxide, fluorine doped silicon oxide, SiC, silicon nitride, and silicon oxynitride.

41. (currently amended) The contact interconnect structure of claim [[36]] 38, wherein the first and second contact layers each comprise a lowermost etch stop layer selected from the group consisting of silicon carbide, nitrogen doped silicon oxide, silicon nitride, and silicon oxynitride.

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42. (currently amended) The contact interconnect structure of claim [[36]] 38, wherein the first plurality and the second plurality of metal filled contact openings comprise conductive materials selected from the group consisting of Cu, W, Al, AlCu, TiN, TiW, Ti, TaN, and Ta.

43. (currently amended) The contact interconnect structure of claim [[36]] 38, wherein the active contact regions are selected from the group consisting of source and drain regions and gate electrodes.

44. (currently amended) The contact interconnect structure of claim [[36]] 38, wherein the active contact regions comprise a conductive material selected from the group consisting of Ti, Co, Ni, Pt, W, TiSi₂, CoSi₂, NiSi, PtSi, WSi₂, TiN, and TaN.

45. (new) The contact interconnect structure of claim 18, wherein the first plurality and the second plurality of metal filled contact openings comprise the same metal filling.

46. (new) The contact interconnect structure of claim 18, wherein the first plurality and the second plurality of metal filled contact openings are physically connected to one another with

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respective metal fillings.

47. (new) The contact interconnect structure of claim 32, wherein the first plurality and the second plurality of metal filled contact openings comprise the same metal filling.

48. (new) The contact interconnect structure of claim 32, wherein the first plurality and the second plurality of metal filled contact openings are physically connected to one another with respective metal fillings.

49. (new) The contact interconnect structure of claim 38, wherein the first plurality and the second plurality of metal filled contact openings comprise the same metal filling.

50. (new) The contact interconnect structure of claim 38, wherein the first plurality and the second plurality of metal filled contact openings are physically connected to one another with respective metal fillings.